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ROGUE RIVER BASIN, OREGON. MEDFORD DIVISION, BEAR CREEK

Public Health Service
Portland, Oregon

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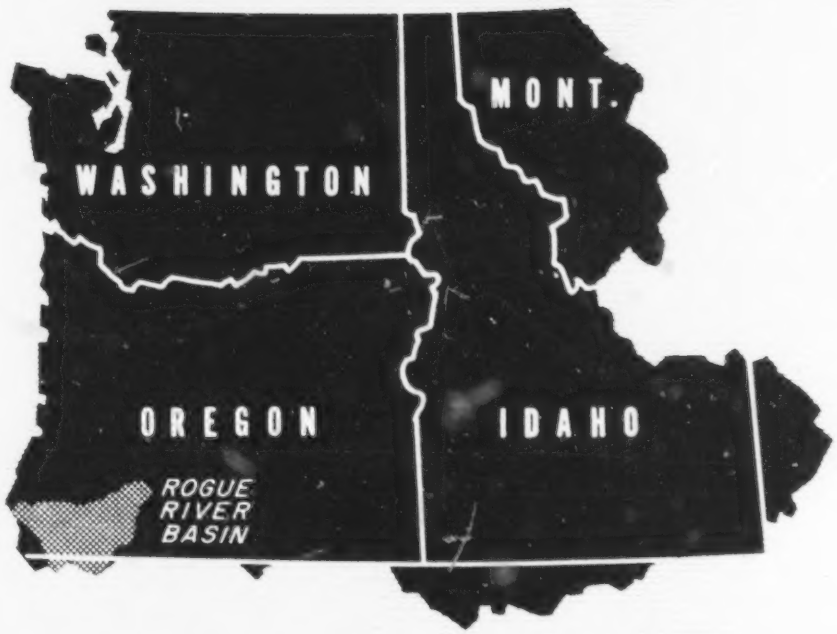
WATER QUALITY CONTROL STUDY

Rogue River Basin, Oregon

Medford Division



OCTOBER 1965

U.S. DEPARTMENT OF HEALTH, EDUCATION AND WELFARE

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Rogue River Basin, Oregon—
Medford Division.....

Bear Creek

A SURVEY HAS BEEN MADE WHICH DISCLOSES A NEED FOR STREAM FLOW REGULATION FOR THE PURPOSE OF WATER QUALITY CONTROL IN BEAR CREEK, A TRIBUTARY OF THE ROGUE RIVER. THIS CONCLUSION IS BASED UPON ECONOMIC, DEMOGRAPHIC, AND ENGINEERING STUDIES. FUTURE CONDITIONS ARE BASED ON PROJECTED POPULATION AND INDUSTRIAL GROWTH.

Prepared at the Request of the

Area Engineer, Lower Columbia Development Office
U.S. Bureau of Reclamation, Salem, Oregon

by the

U.S. DEPARTMENT, OF HEALTH, EDUCATION, AND WELFARE
Public Health Service, Region IX
Portland, Oregon

LIST of TABLES

Table No.		Page No.
V-1	Expected Mean Monthly Flow, Bear Creek @ Medford	11
V-2	Water Rights Summary, Bear Creek Basin	11
V-3	Bear Creek Water Quality Data Summary	12
VI-1	Present & Projected Employment, by Major Industry, Jackson County	16
VI-2	Population, Bear Creek Economic Study Area, 1960	17
VI-3	Present and Projected Population, Bear Creek Economic Study Area	19
VII-1	Municipal Water Supply Data, Bear Creek Basin .	21
VII-2	Summary of Water Requirements, Bear Creek Basin, Acre-Feet Per Year	21
VIII-1	Coho (Silver) Salmon Potential With Minimum Flow Requirement of 75 cfs, Bear Creek	22
VIII-2	Municipal and Industrial Waste, Bear Creek Basin	26
VIII-3	Present & Projected Waste Loadings, Bear Creek Basin	27
VIII-4	Present & Projected Deficiencies, Bear Creek at Medford, Ten-Year Recurrence Interval	29

TABLE of CONTENTS

	Page No.
I. INTRODUCTION	
A. Request and Authority	2
B. Purpose and Scope	2
C. Acknowledgments	3
II. SUMMARY of Findings and Conclusions	
A. Summary of Findings	4
B. Conclusions	5
III. PROJECT DESCRIPTION	
A. Location	6
B. Project	6
IV. STUDY AREA DESCRIPTION	
A. Boundaries	8
B. Physical Features	9
V. WATER RESOURCES of the Study Area	
A. Surface Water	10
B. Ground Water	13
VI. THE ECONOMY	
A. General	15
B. Present	15
C. Factors Influencing Future Growth	17
D. Projected Future Population	18
VII. WATER REQUIREMENTS Municipal & Industrial	
A. Present Water Use	20
B. Forecast of Future Needs	20
VIII. WATER QUALITY CONTROL	
A. Water Use and Need for Control	22
B. Municipal and Industrial Pollution	26
C. Water Quality Criteria	27
D. Flow Regulation	28
IX. BENEFITS....Water Quality Control	30
X. BIBLIOGRAPHY	31

I. INTRODUCTION

A. REQUEST AND AUTHORITY

The request for the investigation was made by the Bureau of Reclamation, Regional Office, Region I, Boise, Idaho, in a letter dated June 20, 1962. The request was for an evaluation of streamflow requirements for water quality control and for an estimate of benefits that might be derived through releases from storage for this purpose.

Authority for the investigation is the Federal Water Pollution Control Act, as amended (33 U.S.C. 466a (b)).

B. PURPOSE AND SCOPE

The investigation was undertaken to determine the potential need for and value of storage for regulation of streamflows for water quality control in the Rogue River Basin Project, Medford Division, Jackson County, Oregon.

The scope of this study was limited to determination of water quality control requirements within the Bear Creek portion of the Medford Division. Study elements included projection of the population and industry growth, determination of sources, and effects of present and future waste loadings, an examination of the hydrology of the area, a determination of the assimilative capacity of the stream, a determination of stream uses and required quality objectives, a projection of adequate treatment levels and flow requirements necessary to protect stream uses, and consideration of alternative methods, costs, and values of meeting water quality requirements.

Preliminary estimates of water quality flow requirements were submitted to the Corps of Engineers in a letter dated December 1, 1961, for the following locations: Rogue River near Medford and near Grants Pass; and Bear Creek near Ashland and near Medford. Existing streamflows were shown to be adequate to meet projected waste loading in the Rogue River but inadequate in Bear Creek. It is the purpose of this report to substantiate and better define the flow needs in Bear Creek.

Water quality control requirements are projected for the design years of 1985 and 2010. These requirements are based upon maintaining a dissolved oxygen quality objective, assuming a minimum treatment prior to discharge of 85 per cent organic BOD removal of projected municipal and industrial wastes.

The conclusions presented are subject to confirmation, pending completion of comprehensive water supply and water quality management studies being conducted in this region by the Columbia River Basin Comprehensive Program for Water Supply and Pollution Control. The water quality flow requirements and values are suitable for project feasibility determinations.

C. ACKNOWLEDGMENTS

Information for this report was provided by officials of the Cities of Ashland, Talent, Phoenix, Medford, and Grants Pass; Oregon State Board of Health; Oregon State Water Resources Board; State Engineer's Office; Rogue Basin Flood Control and Water Resources Association; Jackson County Court; Oregon State Game Commission; Oregon State Fish Commission; Bureau of Sport Fisheries and Wildlife; National Park Service; Corps of Engineers; Bureau of Reclamation; U. S. Geological Survey; the engineering firms of Clark and Groff Engineers, Inc., and Correll, Howland, Hayes and Merryfield; and Jackson County Parks and Recreation Department. The cooperation of all individuals and groups is gratefully acknowledged.

II. SUMMARY of Findings and Conclusions

A. SUMMARY OF FINDINGS

1. The Medford Division is located in Southwestern Oregon, in Jackson County, near the town of Gold Hill and the City of Medford. The study area includes Bear Creek drainage and portions of the Little Butte Creek and Antelope Creek drainages.

2. The Medford Division is under study by the Bureau of Reclamation for the principal purpose of supplying additional water for new and supplemental irrigation. Water allocated for irrigation in the authorized Lost Creek and Elk Creek multiple-purpose reservoirs of the Corps of Engineers will be utilized in this development.

3. In planning for the distribution of stored water for irrigation use, the Bureau of Reclamation will consider the delivery of water to the Division area for water quality control, recreation, and fish and wildlife enhancement.

4. The Bear Creek Basin has a drainage area of 341 square miles (total Rogue River Basin - 5,160 square miles). The average annual yield of Bear Creek is 112,000 acre-feet, with a minimum yield of some 10- to 12,000 acre-feet estimated for 1931. The hydrology of the Bear Creek Basin is complicated by transbasin and interbasin diversions. Ground water is limited and, therefore, of minor significance in most of the Bear Creek Basin.

5. The economic study area consists of Jackson County (population 74,000), which wholly encompasses the Medford Division and the Bear Creek Basin (population 60,000). The economy of the county is based primarily upon lumber and wood products, agriculture (including food processing), tourism, and recreation.

6. Bear Creek is used extensively for irrigation and to a limited extent for fish propagation. The creek is important to Ashland, Medford, and several smaller communities for park developments and other water-oriented activities.

7. Bear Creek receives about 5,800 population equivalents (PE) of unstable organic wastes per day from municipal and industrial sources. The receiving flows are highly variable due to diversions for irrigation; and, at various times and places, flows are essentially depleted.

B. CONCLUSIONS

1. Sufficient storage to meet future needs for municipal and industrial water supply in the study area has been authorized in Lost Creek and Elk Creek Reservoirs of the Corps of Engineers.

2. Existing streamflows of Little Butte Creek and Antelope Creek are considered adequate to meet present and projected waste loads.

3. Maintenance of water quality is needed in the 23 miles of Bear Creek to protect fish and wildlife, provide recreational opportunities, and preserve the aesthetic attractiveness of the stream. Adequate waste treatment, controlled surface and subsurface drainage, and assured quantities of streamflow to maintain dissolved oxygen (DO) levels at or above 6 milligrams per liter (mg/l) are needed.

4. Sufficient streamflow on a one-in-ten year low-flow frequency basis would provide satisfactory protection of stream uses. With adequate waste treatment, residual organic loads to Bear Creek by the years 1985 and 2010 are projected to be 7,100 PE and 12,500 PE per day, respectively. One-in-ten year low flows in Bear Creek are inadequate for protection of present and future stream uses.

5. There is a need, beginning immediately upon completion of the project, for a draft on storage to yield some 3,000 acre-feet. By the end of the study period, there will be a need for an annual draft on storage of 12,760 acre-feet for maintenance of water quality in Bear Creek between the City of Ashland and the mouth of Bear Creek.

6. The value of benefits attributable to storage for regulation of streamflow for water quality control is considered to be at least equal to the cost of providing releases from an alternative single-purpose reservoir, including cost of delivery facilities. The least-cost alternative storage site is adjacent to the study area on McNeil Creek, a tributary of Big Butte Creek.

7. The minimum value assignable to an annual draft on storage of 12,760 acre-feet based on delivery costs to Bear Creek, 100-year project life, needs beginning at the time of project completion, and interest at 3.125 per cent, is estimated to be $522,000 or $41.00 per acre-foot.

8. The benefits derived from water quality maintenance in Bear Creek are both tangible and intangible, and are widespread both in area and in type of beneficiary.

III. PROJECT DESCRIPTION

A. LOCATION

The Rogue River and its tributaries drain 5,160 square miles in the southwestern corner of the State of Oregon and the northern edge of California. More than 2,500 streams comprise the drainage system, resulting in highly dissected land forms cut by hundreds of stream valleys. Bear Creek (drainage area - 341 square miles) lies within Jackson County and has the heaviest concentration of population and the highest level of development of any region in the Rogue River Basin.

A portion of the drainages of Little Butte Creek and Antelope Creek is included in the study area because these areas could be served by the existing and proposed distribution canals which will carry water from the proposed Lost Creek and Elk Creek Reservoirs to the Bear Creek drainage.

B. PROJECT

The Medford Division features include: a diversion dam on Elk Creek; seven pumping plants located on the main canals for reaching areas of higher elevation; about 100 miles of canals; siphons and miscellaneous features; and drainage works. Acreage to be served would include about 21,100 acres of new lands and some 6,380 acres in need of supplemental water. These lands are located in Medford, Rogue River Valley, Eagle Point, and Sams Valley Irrigation Districts, and the Shady Cove area.

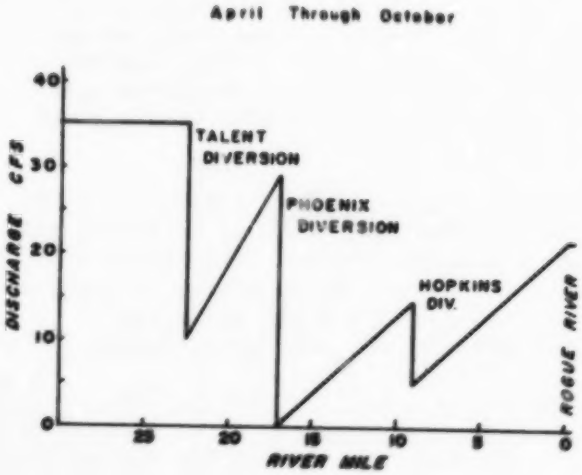
In plans for storage, the Corps of Engineers has considered flood control, power, water supply, fish and wildlife enhancement, water quality control, and recreation. The Bureau of Reclamation, in its plans to utilize water from storage in Elk Creek and Lost Creek Reservoirs for irrigation, is involved in the transportation of water for fish and wildlife, and water quality control.

Water required for the various functions would be released downstream from Elk Creek and Lost Creek Reservoirs, on Elk Creek and Rogue River, respectively, and diverted into Rogue Canal. This canal would parallel Rogue River to a separating diversion structure below Shady Cove. From this structure, Sams Valley Canal would cross Rogue River to supply irrigation needs in Sams Valley, and Eagle Point Supply Canal would extend down the river to supply multiple-purpose requirements in the area near Medford.

At the present time, transbasin diversions from Little Butte Creek flow into Howard Prairie Reservoir but do not enter Hyatt Prairie Reservoir. Hyatt Prairie Reservoir receives inflow only from its own drainage area. Releases from Hyatt Prairie Reservoir flow down Keene

Creek to Keene Creek Diversion Dam. Releases from Howard Prairie Reservoir flow through Howard Prairie Delivery Canal to Keene Creek Diversion Dam. From Keene Creek Diversion Dam the water enters a system of tunnels and penstocks which carry it to Green Springs Power Plant. The power plant discharges into Emigrant Creek, and the water then flows into Emigrant Reservoir (40,500 acre-feet). Maximum releases from Emigrant Reservoir into East Lateral Canal are 143 cfs maximum.

BEAR CREEK



DRY YEAR FLOW PROFILE

During much of the non-irrigation season (October 15 to April 15), flows from Emigrant Reservoir to Bear Creek are low or nonexistent. A few small creeks add some flow, most of which is diverted just above the Ashland sewage treatment plant outfall. Between Ashland and Talent, flows again build up from small creeks and from return irrigation flows until the flow is again diverted at the Phoenix diversion downstream from the Talent sewage treatment plant outfall. Absolute values vary, depending on demands within the basin, but the sawtooth profile shown has been noted during the irrigation season for many years.

Public health officials, fishery groups, water resources and recreational interests, and the cities through which Bear Creek flows, are all concerned because there are periods of no flow in the creek at diversion points. To correct this condition, these groups met with the Corps of Engineers and the Bureau of Reclamation to determine the feasibility of an inter-basin diversion of water from the proposed Elk Creek Dam and Lost Creek Dam in the Rogue River Basin to the vicinity of Talent. Preliminary studies by the Bureau of Reclamation indicate that it would be feasible to bring water from the proposed dams to the area of Talent by enlarging existing canals and adding some new sections.

IV. STUDY AREA DISCRIPTION

A. BOUNDARIES

In its 25-mile length, Bear Creek flows through or is adjacent to the Cities of Ashland, Talent, Phoenix, and Medford. (See location map at the back of the report.) Outlying cities are Jacksonville, Central Point, Eagle Point, and various water districts or other unincorporated places. Most of the industrial development (primarily wood products and agricultural products) is in the vicinity of Medford.

For purposes of economic analysis and projection in connection with the Bear Creek Project, a group of eight 1960 Census County Divisions has been selected to comprise the economic base study area. The Census Divisions used, the boundaries of which are shown in "U. S. Census of Population, Oregon, Number of Inhabitants (PC1, 39A)," are the following: Ashland, Central Point, Jacksonville, Medford, Medford Rural, Phoenix, Sams Valley, and Talent.

The water quality study area considered in this report is limited to the Bear Creek drainage and the lower portions of Little Butte and Antelope Creeks; the main stem Rogue has been considered in previous studies. (See Chapter I, Section B.)

B. PHYSICAL FEATURES

Bear Creek Valley has more expanse of agricultural lands than any other valley in the Rogue River Basin, even though 60 per cent of its area is unsuitable for farming because of mountainous terrain. Valley elevations run from 1,140 feet above mean sea level near the mouth of Bear Creek to 2,000 feet in the vicinity of Ashland. Mount Ashland, located in the southern part of the subbasin near the headwaters of Ashland Creek, is the highest point in the subbasin (elevation 7,533 feet), and there are four other peaks in the area above an elevation of 5,000 feet.

The slope of Bear Creek main stem is relatively mild compared with other streams in the basin, averaging 28 feet of drop per mile, but the slope of Ashland Creek, one of the major tributaries, is more than 400 feet per mile.

The lowest average annual precipitation in the Rogue River Basin (less than 20 inches) occurs in the Bear Creek Valley in the Medford area, while the annual precipitation is nearly 30 inches in the southern part of the Bear Creek Basin and around 24 inches in the northwestern part. About 30 per cent of the annual precipitation occurs during the irrigation season (May 15 to October 15). Snowfall is light in this section, with an average annual fall of four inches at Medford Experiment Station, increasing to nearly 18 inches at Ashland. A high of 137 inches occurs at the Siskiyou summit in the extreme southeastern corner of the basin.

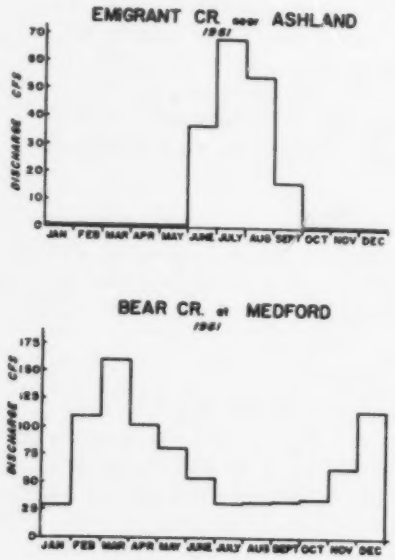
Temperatures in the basin are mild, with an average range of highs and lows below elevation 1,350 from 81 to 47 degrees Fahrenheit in the summer months and 54 to 33 degrees in the winter. Average variations at elevations near 4,500 feet are from 68 to 46 degrees in the summer and 45 to 33 degrees in the winter.

The annual growing season in this valley averages about 220 days.

V. WATER RESOURCES of the Study Area

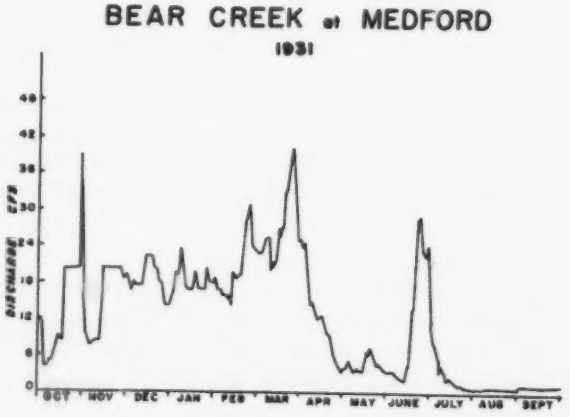
A. SURFACE WATER

The hydrology of the Bear Creek Basin is complicated by trans-basin and internal diversions, which alternately deplete and replenish the stream. Records from two U. S. Geological Survey gaging stations give an indication of streamflow conditions. The gage data from the station on Emigrant Creek near Ashland (19 per cent of the Bear Creek drainage) show an average annual yield of some 17,000 acre-feet (affected by regulation). Unregulated average annual yield is estimated at some 24,000 acre-feet. The records for the gage on Bear Creek at Medford (85 per cent of the Bear Creek drainage) indicate an average regulated annual yield of some 72,000 acre-feet.


EMIGRANT CR. near ASHLAND
1961
DISCHARGE CFS
JAN FEB MAR APR MAY JUNE JULY AUG SEPT OCT NOV DEC
BEAR CR. at MEDFORD
1961
DISCHARGE CFS
JAN FEB MAR APR MAY JUNE JULY AUG SEPT OCT NOV DEC

MEAN MONTHLY DISCHARGE HYDROGRAPHS

The extensive regulation of Bear Creek by Emigrant Reservoir is reflected, for example, in the discharge records for 1961. Water stored in Emigrant Reservoir during the winter months is released during the irrigation season to Emigrant Creek, a tributary of Bear Creek. Diversions are made from Bear Creek for irrigation, with a portion of the water again entering the stream as irrigation return flow.



DAILY FLOW HYDROGRAPH, LOWEST YIELD WATER YEAR

A daily hydrograph for the low-yield water year of 1931 illustrates the flow conditions which may be expected during critical years at the Medford gage.

TABLE V-1
EXPECTED MEAN MONTHLY FLOW
BEAR CREEK AT MEDFORD, CFS

Month	Recurrence Intervals - Years			
	Two	Five	Ten	Twenty
January	78	47	20	6.6
February	161	97	41	14
March	186	112	47	16
April	161	97	41	14
May	93	56	24	7.9
June	48	29	12	4.1
July	16	10	4.2	1.4
August	15	9	3.8	1.3
September	16	9.5	4.0	1.4
October	23	14	5.9	2.0
November	39	23	10	3.3
December	63	38	16	5.4
Mean Annual	75	45	19	6.4

Data from the Medford gage was utilized to develop expected low flows for two-, five-, ten-, and twenty-year frequencies, as shown in TABLE V-1.

TABLE V-2
PRIMARY WATER RIGHTS SUMMARY
BEAR CREEK BASIN

Use	Stream	CFS
Domestic	All Basin Streams	4.1
Municipal	Ashland Creek	27.7
	Jackson Creek	2.0
		29.7
Irrigation	Bear Creek	120.0
	Emigrant Creek and Tributaries	350.4
	Griffin Creek	77.8
	Jackson Creek	32.8
	Others	270.9
		851.9
Power	Ashland Creek	54.0
	Wagner Creek	30.0
	Others	1.5
		85.5
Industrial	All Basin Streams	6.4
Mining	All Basin Streams	33.5
Recreation	All Basin Streams	0.2
Wildlife	All Basin Streams	1.8
Fishlife	All Basin Streams	0.5
Pollution Abatement	None	---
TOTAL, BEAR CREEK BASIN		1,013.6

SOURCES: Oregon State Water Resources Board "Rogue River Basin" Report;
Bureau of Reclamation

Comparison of the expected monthly flows (TABLE V-1) with the water rights summary (TABLE V-2) makes it apparent that rights to use water exceed the expected available flows.

Available data on the present quality of the water of the Rogue River and Bear Creek were tabulated from records of the Oregon State Sanitary Authority and the U. S. Geological Survey. These data tabulations are shown in TABLE V-3. Because the data are not sufficient for a statistical treatment, it is only possible to generalize on the overall appearance of the information.

TABLE V-3
BEAR CREEK WATER QUALITY DATA SUMMARY

Place of Sample	Number of Samples	Dates of Samples	Temp °F	Temp °C	pH	DO mg/l	DO % Sat.	BOD mg/l	Conductance	MPN	Color	Turbidity	Alkalinity mg/l	$CaCO_3$ Hardness mg/l	Total Solids mg/l	Dissolved Solids mg/l	NO_3 mg/l	PO_4 mg/l	Cl mg/l	Iron (Fe) mg/l	Sodium mg/l
(1) Bear Creek County Rd Bridge 1 Mile North of Control Point	19																				
	Mean	7-11-60	57	13.8	7.9	10.8	107	3.0	232	24,000	25	90	122	106	240	177	1.14	0.59	11.7	0.44	14
	Max.	9-10-62	87	31	8.4	14.0	147	7.8	340	30,000	100	300	184	144	440	281	3.6	1.13	20.55	1.0	19
	Min.		32	0	7.5	7.0	86	1.2	98	210	5	5	39.4	76	171	166	0.1	0.36	5.8	0.1	11
(2) Bear Creek Hwy 62 Bridge 1 Mile North of Medford	19																				
	Mean	7-11-60	57	14	8.1	11.1	110	2.0	276	6,100											
	Max.	9-10-62	84	29	9.1	14.8	191	4.2	370	24,000											
	Min.		32	0	7.6	7.6	84	0.7	178	600											
(3) Main Street Bridge Medford	30																				
	Mean	7-11-60	55	13	8.0	11.9	117	3.0	281	8,100	30	5	144.9	171	394	228	0.34	0.587	19.00		
	Max.	9-10-62	81	27	9.0	16.6	198	9.1	380	30,000	(One sample 7-11-60)			(One sample 7-11-60)							
	Min.		32	0	7.3	7.3	89	0.6	67	45											
(4) Fern Valley Road Bridge Talent	19																				
	Mean	7-11-60	56	13.5	8.1	11.8	114	2.4	295	3,900											
	Max.	9-10-62	82	27.5	9.5	14.8	165	12.8	500	7,000											
	Min.		35	2	7.4	7.6	66	0.9	175	60											
(5) County Road Bridge Opposite Jackson Hot Springs	30																				
	Mean	7-11-60	54	12	7.6	10.0	96	3.3	215	23,000											
	Max.	9-10-62	75	24	8.4	12.6	136	7.7	350	70,000											
	Min.		36	2	7.1	4.7	47	0.7	72	450											
(6) Fish Lake Road (Mountain Ave. - Ashland)	30																				
	Mean	7-11-60	53	11.7	8.0	10.7	107	3.0	241	3,300	50	30	87.5	91.7	345	278	0.03	0.076	22.95		
	Max.	9-10-62	77	25	8.8	12.5	128	5.8	470	7,000	(One sample 7-11-60)			(One sample 7-11-60)							
	Min.		36	2	7.3	6.8	79	0.7	144	45											
Constant Bridge on Control Point Road 0.4 Mile East of Control Point	14																				
	Mean		55	12.3	7.9				257		18	110	128	102	280	170	1.3	0.53	9.5	0.35	14
	Max.		75	24	9.0				351		35	300	184	144	554	270	3.6	0.76	14	2.0	19
	Min.		58	3.3	7.1				200		*	5	94	61	172	130	0.2	0.36	5.8	0.1	11

During July and September of 1960 and 1962, the pH of Bear Creek water at Medford was about 8.0; dissolved oxygen (DO) content ranged from 7.6 to 14.8 mg/l; biochemical oxygen demand (BOD) ranged from 0.7 to 4.2 mg/l; and the most probable numbers (MPN) of coliform bacteria, which are indicators of sewage pollution, ranged from 600 to 24,000 organisms per 100 ml. Streamflows at the time of these samplings were not measured; however, by interpretation and calculation, using known waste loads and the typical flow profile shown in Chapter III, Section B, it is apparent that lower DO's and higher BOD's would at times occur.

B. GROUND WATER

The City of Talent and the neighboring Cities of Ashland, Phoenix, and Medford lie on the broad valley floor of the Bear Creek drainage. The valley sediments consist of bedded sandstones, shales, and conglomerates of fresh and brackish water deposition. These rocks are fine-grained and do not yield water to wells readily. Often deep wells in this formation produce brackish water and exhibit extreme drawdowns while yielding water in quantities less than 10 gallons per minute (GPM). A number of deep wells in this same formation, but outside the Bear Creek Basin, contain water with excessive fluoride, boron, and sodium.

The Umpqua beds also form the rolling hills along the northern side of the Bear Creek Valley, and most wells in this region are adequate for domestic water supply only. The flanks of Bear Creek Valley are made up of a complex series of igneous and metamorphic rocks, both of which have poor water-bearing characteristics and are not reliable sources of ground water. Some weathered granitic bodies do store varied amounts of ground water suitable for domestic water supply.

No ground water quality data were found for Bear Creek Basin, except the one sample from the Talent well, which indicated that the water may be harder and have more dissolved solids than surface water but is still well within the U. S. Public Health Service Drinking Water Standards.

VI. THE ECONOMY

A. GENERAL

The demand for water for municipal and industrial purposes, and the amount and character of waste waters resulting from such uses, are determined largely by the activities associated with a region's economic base. The purpose of this section is to present economic and demographic data to be used as a basis for projecting the needs for water for municipal and industrial purposes and for estimating the future amounts and types of waste and land drainage material that may be expected to occur in the Bear Creek Basin with the expanded development anticipated in the future.

B. PRESENT

1. Industry and Employment

For purposes of this report, it is assumed that the pattern of industrial activity and employment in the economic base study area is close to that of Jackson County as a whole. The study area's population comprises 84.5 per cent of the total Jackson County population. In the portion of Jackson County outside the study area, there are only three incorporated places, having a total 1960 population of 1,512. The study area also includes most of the agricultural land of Jackson County. Hence, for both urban and rural employment, the study area is well described by analyzing data for the county.

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TABLE VI-1 shows employment, by major industry, in Jackson County in 1960, with a comparison of its percentage distribution with that in the United States as a whole. The table shows that the economy of Jackson County is heavily dependent on processing the timber resource (shown by the categories "forest management," "logging," and "lumber and wood products"). Three-quarters of all manufacturing employment was in lumber and wood products in 1960. Employment in agriculture is also above the national average.

TABLE VI-1
PRESENT & PROJECTED EMPLOYMENT, BY MAJOR INDUSTRY
JACKSON COUNTY

Industry Category	1960 % Distribution		Employment		
	Jackson Co.	U.S.	1960	1985	2010
Agriculture	8.1	6.1	2,190	2,000	2,000
Forest Management, Fisheries	0.8	0.1	223	300	400
Mining	0.3	0.9	70	100	100
Manufacturing, TOTAL	20.3	25.1	5,531	9,100	14,400
Logging, Lumber, Wood Products	15.1	1.6	4,103	4,100	4,100
All Other Durables	2.1	12.4	572	2,300	6,100
Food & Kindred	1.6	2.6	444	800	1,100
Printing, Publishing & allied	1.3	1.7	344	600	900
All other nondurables & Misc.	0.2	6.8	68	1,300	2,200
Construction	6.5	5.5	1,757	2,200	3,800
Services	57.0	54.8	15,529	27,700	50,600
Military	0.1	2.5	38	200	400
Unemployment	6.9	5.0	1,882	2,200	3,800
TOTAL LABOR FORCE	100.0	100.0	27,220	43,800	75,500

Source: U. S. Census of Population, 1960

The above-average employment in services reflects the fact that the study area is so far from larger urban centers (Portland or San Francisco) that it is relatively autonomous in services. The high service-industry employment also results from the fact that recreation, tourism, and in-migration of retired persons are important to the economic base of the Rogue Valley and of the study area.

2. Population

The total labor force of 27,220, in April 1960, supported a Jackson County population of 73,962; that is, the ratio of population to labor force was 2.7. Of this total Jackson County population, 84.5 per cent (62,490) were in the Census Divisions comprising the Bear Creek study area.

TABLE VI-2
POPULATION, BEAR CREEK ECONOMIC STUDY AREA[1/]

Location	1960
Urban Portion:	41,700
Medford Urban Area[2/]	26,731
Ashland	9,119
Central Point	2,289
Jacksonville	1,172
Phoenix	769
Eagle Point	752
Talent	868
Non-Urban Portion:	20,790
TOTAL	62,490

1/ For list of Census Divisions comprising the economic study area, see Chapter IV, Study Area Description.
2/ 1960 Population Medford City 24,425; "South Medford" Suburb 2,306.
SOURCE: U.S. Census of Population, 1960.

TABLE VI-2 shows the allocation of this population among the incorporated places, urban and non-urban portions of the study area. Of the total study area population, 66.7 per cent (41,700) were in incorporated places or in the Medford urban area. A substantial part of the remaining population, shown in Table VI-2 as "non-urban," was located around the peripheries of the incorporated places and hence was more suburban than rural.

C. FACTORS INFLUENCING FUTURE GROWTH

With 15 per cent of its labor force in lumber and wood products manufacturing, Jackson County's economy is highly specialized. The outlook for growth in Jackson County depends on possibilities for (1) maintaining or increasing the annual timber harvest; and (2) diversifying the economy, either by further fabrication of the total timber resource in secondary manufacturing or by development of new industries not related to the timber base.

A Forest Service study* has projected an increase of about 25 per cent in total timber harvest in the Southwestern Oregon area during the next 25 years. Some industrial growth can be expected in Jackson County from more efficient utilization of this timber harvest. Of the timber resource available, an increasing proportion will go to plywood uses, with a decrease in sawed lumber. Raw materials (wastes and residues) exist in the area in adequate amounts to support a pulp mill; however, it has been concluded, based upon existing and contemplated legislation,

*Prospective Economic Developments Based on the Timber Resources of the Pacific Northwest, March 1965, Table 108.

and public opinion regarding the Rogue River as a recreation stream, that the establishment of such a mill will be precluded. Instead, it is concluded that the raw material will be shipped out of the county to be processed or the material will be used to fabricate particle or hardboard, which are low waste-producers.

It is expected that agricultural and food-processing employment and production will increase moderately in Jackson County during the study period. The outlook appears good for increases in manufacturing employment in industries not dependent upon either timber harvesting or agriculture. An example is the film and copying paper plant recently located at Medford. The electronic components plant at Grants Pass also illustrates the sort of diversification expected to occur in Jackson County.

Service industries, related to recreation and tourism, are an important part of the economic base of Jackson County at present, and it is expected that employment in this sector will grow substantially in the future. It will be stimulated further by the popularity of the Rogue Valley as a place for retirement.

D. PROJECTED FUTURE POPULATION

It is expected that earlier retirement and an increasing population of retired persons in the Rogue Valley will lead to an increase in the future in the ratio of population to total labor force. At present, the ratio is about 2.7, and it is expected that it will be 2.9 by 1985 and 2010. On that basis, the total labor force projected in TABLE VI-1 would support a population in Jackson County of 127,000 by 1985 and 219,000 by 2010. Population in the Bear Creek economic study area comprised about 85 per cent of the total Jackson County population in 1960. This percentage will increase in the future, however, because it is expected that there will be little or no population growth in the parts of Jackson County outside the economic study area. On the basis that county population outside the economic study area will remain, in the future, at about its present level, population in the Bear Creek economic study area would be about 116,000 by 1985 and 208,000 by 2010.

For purposes of allocating study area population among the areas and cities shown in TABLE VI-3, it is assumed that population in the non-urban portion of the study area will remain at about the present level and that growth rates will be about the same in the various urban areas. This does not mean that the presently unincorporated portions will not grow in population, since annexations are likely to result in the cities absorbing surrounding suburbs as they are built up. For planning purposes, a reasonable allocation of estimated future population among the urban areas is given in TABLE VI-3.

TABLE VI-3
PRESENT AND PROJECTED POPULATION
BEAR CREEK ECONOMIC STUDY AREA 1/

	1960	1985	2010
Urban Portion:	41,700	95,200	187,200
Medford Urban Area 2/	26,731	61,600	121,300
Ashland	9,119	21,200	40,800
Central Point	2,289	5,100	10,400
Jacksonville	1,172	2,500	5,300
Phoenix	769	1,700	3,400
Eagle Point	752	1,200	2,100
Talent	868	1,900	3,900
Non-Urban Portion:	20,790	20,800	20,800
TOTAL, Bear Creek Economic Study Area	62,490	116,000	208,000

1/ For list of Census Division comprising the economic study area, see Chapter IV, Study Area Description.

2/ 1960 population Medford City 24,425; "South Medford" Suburb 2,306.

SOURCE: U. S. Census of Population, 1960.

VII. WATER REQUIREMENTS
Municipal & Industrial

A. PRESENT WATER USE

There are four separate water systems in the Bear Creek Basin, as shown in TABLE VII-1. Ashland and Talent have coagulation, filtration, and chlorination facilities to treat for high turbidities and high numbers of coliform organisms that occur during portions of the year. Industrial supplies, for the most part, are served by municipal systems, since much of the industrial development is adjacent to or within the cities. A few industries use ground water sources, but these uses are minor.

B. FORECAST OF FUTURE NEEDS

A municipal and industrial water supply study for the Rogue River Basin has been completed by the Public Health Service and was forwarded to the Corps of Engineers*; the findings and conclusions of this study are presently valid. TABLE VII-2, from that report, lists the existing water supply capability, projected future requirements, and the net storage which would be needed to fulfill such projected needs. The authorized Corps of Engineers' Rogue River Basin Project includes 20,000 acre-feet of storage space for meeting the Rogue River Basin needs (including Bear Creek).

* "Report on Municipal and Industrial Water Supply, Rogue River Basin, Oregon," U. S. Public Health Service, Portland, Oregon, June 1959."

TABLE VII-I

MUNICIPAL WATER SUPPLY DATA
BEAR CREEK BASIN

City	1960 Population	Source of Water
Ashland	9,120	Ashland Creek
Phoenix	800	Wells
Talent	900	Talent Irrigation Dist., Wagner Creek, and Wells
Medford[1/]	24,400	Big Butte Springs
Eagle Point	900	Served by Medford
Central Point	2,500	" " "
Jacksonville	1,300	" " "
Charlotte Anne WD	350	" " "
Elk City WD	200	" " "
Jacksonville Hwy. WD	1,300	" " "
King's Hwy. WD	660	" " "
Maple Park WD	600	" " "
White City Water Co.	150	" " "

1/ Total population served by Medford 32,600.

TABLE VII-2

SUMMARY OF WATER REQUIREMENTS, BEAR CREEK BASIN[1/]
ACRE-FEET PER YEAR[2/]

City	Existing Supply or Water Rights	Total 2010 Requirements	Net Water From Future Storage Reservoir
Ashland	6,700	9,200	2,500
Central Point	3/	3/	3/
Eagle Point	3/	3/	3/
Jacksonville	3/	3/	3/
Medford	28,000[4/]	33,600	5,600
Phoenix	690	1,280	5/
Talent	130	940	810[6/]
TOTAL	35,520	45,020	8,910

1/ Condensed from table in "Report on Municipal & Industrial Water Supply, Rogue River Basin, Oregon", June, 1959, USFWS, Portland, Oregon
2/ Excludes industrial water use above the present rate.
3/ Included with City of Medford.
4/ Hold 100 cfs (71,600 Ac-Ft./Yr.) rights on Rogue River.
5/ Ground water to be developed for future supply.
6/ Exchange of water rights proposed.

*"Report on Municipal & Industrial Water Supply, Rogue River Basin, Oregon", June, 1959, by USFWS, Portland, Oregon.

VIII. WATER QUALITY CONTROL

A. WATER USE AND NEED FOR CONTROL

Bear Creek is extensively used for irrigation, as shown by the diversions and return flows reflected in the sawtooth profile shown on page 7. Bear Creek, in its present state, provides limited fisheries, recreation, and a base for park development. It is also used to receive and assimilate treated wastes from the Cities of Ashland and Talent, and domestic and land-drainage wastes from areas adjacent to the stream.

1. Fisheries

Historically, Bear Creek was a particularly important tributary of the Rogue River in terms of anadromous fish production (steelhead, silver salmon, and cutthroat). The construction of Emigrant Reservoir, about 1924, blocked upper Emigrant Creek to anadromous fish and radically changed the flow pattern of Emigrant Creek below the project. Heavy irrigation demands along the main stem and tributaries, together with diversion structures and unscreened diversions, created almost impossible obstacles for anadromous fish. Silver salmon are no longer found in Bear Creek, while cutthroat trout are limited to native populations in west side tributary headwaters.

In spite of all abuses, an estimated 800 to 1,000 steelhead still use the Bear Creek system, and their young provide an early trout fishery from Talent to Emigrant Dam. There has been little stocking of the area with hatchery fish, and angling has been maintained almost completely on natural production of the native steelhead.

Present management provisions for steelhead in Bear Creek include passage for adults at the diversion structures, screening of diversion ditches to prevent loss of downstream migrating adults and juveniles, and a closed angling season during most of the steelhead spawning period. Recent fish collections revealed juvenile steelhead present as far down as Medford.

TABLE VIII-1
COHO (SILVER) SALMON POTENTIAL WITH MINIMUM FLOW REQUIREMENT OF 75 CFS
BEAR CREEK

Stream Section	Downstream Migrants	Returning Adults @ 1 to 3 Per Cent
Emigrant - Phoenix	54,400	540 to 1,630
Phoenix - Medford	25,300	252 to 760
Medford - Mouth	67,800	678 to 2,030
TOTAL	147,500	1,470 to 4,420

Condensed from preliminary data on coho salmon rearing studies presently being conducted by the Oregon Fish Commission. Original data also includes potential at 50 and 100 cfs.

Fishery agencies have indicated that a considerable potential exists for fishery enhancement, including larger runs of steelhead, reestablishment of silver salmon, and an increased trout fishery. TABLE VIII-1 illustrates the silver salmon potential for several reaches of Bear Creek if a minimum rearing flow of 75 cfs and adequate quality were maintained.

2. Recreation

The planned uses of Bear Creek for recreation at the present time are negligible. In actuality, however, the stream receives considerable attention from the children of the residential areas through which it travels. During an inspection trip in June 1963, numerous children were observed wading or playing in the stream and on its banks.

Developments along Bear Creek above Ashland are rural in nature, with subdivision into two- to three-acre homesites. Recreational uses would be confined to those related to private dwellings in the vicinity of the creek. Bear Creek at Ashland flows through the northeastern portion of the city, where it is relatively unimproved and no recreational use is made of the stream other than by the children in its vicinity. The growth of Ashland and the proposed annexations to the city, however, will bring the city adjacent to the creek along much of its northern border. The City of Ashland has indicated an interest in, and has encouraged the development of, adjacent water resources in order to acquire water-based recreational opportunities.

3. Parks and Streamside Developments

The State Highway Department is proposing to develop two rest areas near Ashland to serve freeway traffic. One of these is a ten-acre tract bordering on Bear Creek. Although these areas are not being planned as water recreation areas, the stream will receive incidental use by rest-area visitors. A general idea of the magnitude of this use can be obtained by examining the attendance at other waysides in the area. It would appear that this attendance would be numbered in the tens of thousands per year if the facilities were available at the present time.

City planners and various civic groups at Medford have indicated the need for and have started various programs designed to utilize Bear Creek as one of the city's recreational assets. The 1960 report* "Planning for Parks and Recreation," by the Bureau of Municipal Research and Service, prepared for the Medford City Planning Commission, proposed that Bear Creek be developed for recreational purposes. This report was extended, in 1963, by a more detailed park plan** prepared by the city. The 1963 report recommends that three additional park areas be developed along Bear Creek, in addition to extensive landscaping. Although the total costs of these proposed developments are not available, the cost of acquisition and initial development of Bear Creek Park, alone, is estimated at a total of $270,000. The final cost is estimated to be $900,000. The city has already acquired most of the 79 acres recommended for the park, and a local civic group has done the initial cleanup. The

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* Financed in part by Federal funds (HHFA).

** "Ashland and Its Urban Fringe," Bureau of Municipal Research and Service, University of Oregon, 1963.

site lies along both sides of Bear Creek and is easily accessible from all parts of the city. The plans for the Bear Creek oriented facility include a lagoon for boating and children's fishing. This development is considered by the community to constitute its most important park facility.

The ultimate development of Bear Creek, in Medford, is for a park extending through the city. As indicated in the 1963 park plans, "The proposed development would be a landscaped strip along both sides of the creek. Improvement and beautification of the banks should also include effort to reduce or eliminate pollution of Bear Creek water, both within and without the City of Medford."

In addition to acquiring park sites and preparing development plans, the city has also engaged a landscape architect firm to prepare the landscaping plans for the Bear Creek area. The extent to which the community is behind this activity to utilize Bear Creek is illustrated by the fact that the Lions Club of Medford has taken on a project of cleaning its banks and has contributed both labor and funds to the project in the anticipation that the stream's quality would be improved.

The Jackson County Planning Commission, in cooperation with the Oregon State Bureau of Municipal Research, is planning a study* of the Ashland-to-Medford portion of the Bear Creek Valley which would provide the basis for creating a "park chain" along Bear Creek. The study would cost from $15,000 to $20,000 and would include Federal matching funds (HHFA), as well as state, county, and city funds. The plans to be developed will capitalize on the area's natural attributes and provide places for such pursuits as hiking, riding, fishing, water-skiing, picnicking, and sight-seeing. In addition to planning for public lands already acquired or available, the study would examine the manner in which adjoining private lands could be retained in private ownership and contribute to the overall development by providing services such as riding stables, fishing ponds, and hunting preserves. These plans are being coordinated with the plans of the Jackson County Park and Recreation Department and the City of Medford. Interest and support have been indicated for this development by the Chambers of Commerce of both Medford and Ashland, as well as the Izaak Walton League.

4. Aesthetic Environment

In addition to the specific categories of water use for which quality is important, which were described in preceding sections, there is a further area of public concern and benefit in connection with the quality of Bear Creek. This might be characterized as the influence of the stream on the study area environment. Although difficult to assess in absolute numerical terms, the impact is real and of major consequence. In the

* Bear Creek Urban Region Planning Project.

Bear Creek Valley, the influence of the stream on the environment is of more than ordinary significance because of the area's importance as a tourist center. Without attempting to describe the actual attractions of the area, it can be noted that the valley is traversed by a major north-south interstate highway; is adjacent to Crater Lake National Park, Oregon Caves National Monument, and the Rogue River; and is host each year to thousands of tourists, including those attending the nationally known Shakespearean Festival at Ashland. In addition to the stream's general impact on the area environment, it also has the potential to exert an influence on the real estate adjacent to it. In order to give dimension to the magnitude of the impact, the following section describes briefly the numbers of persons involved and some of the indications of importance of the stream to the area that can be served.

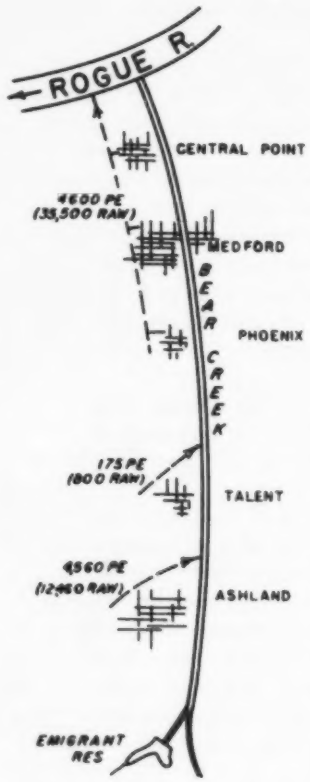
Of the more than 80,000 persons living in Jackson County (1962), about 64,000 live in the relatively small area of the Bear Creek Valley. The stream bisects Medford (population 26,000) and cuts through a corner of Ashland (population 9,500). The importance of the creek in Medford is emphasized by the fact that the major park now developed is adjacent to the creek, and most of the future park plans include the creek. One of the main thoroughfares of Medford (it parallels the creek through the city) is named Riverside Avenue. This is a reminder that at one time Bear Creek was a major stream and was considered to be a principal tributary of the Rogue : The name "Medford," itself, was derived from the fact that it was located at the middle fork of Bear Creek.

Outside of the two cities through which it passes, the creek (in its present state) apparently exerts no positive benefit on the value of adjoining real estate, unless it is in connection with irrigation.

The 10-mile stretch of Bear Creek between Ashland and Medford is parallel to a major north-south interstate highway which has a clear view of the creek through most of this area. The appearance of the water will be observable from the freeway, and the economic blight which wasteways create would be very obvious. Based on Oregon State Highway Department traffic counts, over seven million vehicles a year are currently using this route. The significance of interstate traffic (of which tourists are a major component) is indicated by a traffic count of over one million vehicles per year at a point 17 miles south of Ashland at the Oregon-California border.

B. MUNICIPAL AND INDUSTRIAL POLLUTION

Present waste loadings to Bear Creek are shown in TABLE VIII-2. Locations of the loading points on Bear Creek and on the Rogue River are illustrated in the schematic diagram below. At the present time, all municipal wastes and a portion of the industrial wastes of the Medford and Central Point areas are treated and discharged to the Rogue River.



SCHEMATIC DIAGRAM OF WASTE LOADINGS

TABLE VIII-2
MUNICIPAL AND INDUSTRIAL WASTE
BEAR CREEK BASIN

City	1960 Population	Raw Waste Production Municipal PE	Raw Waste Production Industrial PE	Total Treated Waste to Stream PE	Receiving Stream
Ashland	9,120	11,900	4,000	4,000	Bear Cr.
			300	300	Bear Cr.
			260	260	Bear Cr.
Talent	900	800	---	175	Bear Cr.
Medford*	24,400	35,500	2,000	4,600	Rogue R.
			12,350	12,350	Bear Cr.
			1,580	500	Bear Cr.
			620	620	Bear Cr.

*Includes Phoenix 1960 Municipal PE 750.

Future municipal and industrial waste loadings, as shown in TABLE VIII-3, were projected on the basis of population growth rates for urban areas. The loadings shown are those remaining after adequate treatment (secondary treatment resulting in 85 per cent BOD removal). It is assumed, based on basin-wide planning being conducted for Jackson County*, that all future industrial wastes will be treated and transported to the Rogue River rather than discharged to Bear Creek.

* "Engineering Study of Sewage Collection and Treatment Facilities for the Bear Creek Basin, Jackson County, Oregon," Cornell, Howland, Hayes, and Merryfield, Corvallis, Oregon, February 1965.

TABLE VIII-3
PRESENT & PROJECTED WASTE LOADINGS, BEAR CREEK BASIN

City	Population			Estimated Total PE/Day			Est. PE/Day to Bear Cr.		
	1960	1985	2010	1960	1985	2010	1960	1985	2010
Medford	24,400	45,100	77,000	51,550	95,000	143,000	1,000	2,000*	3,000*
Ashland	9,120	17,000	31,000	12,460	31,000	57,000	4,560	4,600	8,500
Talent	900	1,600	3,000	1,150	2,050	3,900	175	300	590
Phoenix	800	1,400	2,600	750	1,300	2,400	115	195	360

*These values reflect treatment of cannery & meat-packing wastes at existing plant sites. All municipal waste and waste from new industry discharged to Rogue River.

Existing streamflows of Little Butte and Antelope Creeks (adjacent to the study area and subject to potential flow augmentation from canals serving the Medford Division) are considered adequate to meet the minor present and projected waste loads.

C. WATER QUALITY CRITERIA

There is a need to maintain water quality for recreation, fisheries, and protection of general aesthetic conditions in and along Bear Creek. Indicators of water quality involving these uses are:

(1) Dissolved oxygen;
(2) Bacterial pollution (coliform organisms);
(3) Floating, suspended, and settleable solids;
(4) Agricultural chemicals, salts, silts, and other irrigation return flow constituents;
(5) Temperature;
(6) Nuisance aquatic growths.

Water quality for maintenance and restoration of an anadromous fishery requires a DO concentration of at least 6 mg/l at 70 degrees Fahrenheit for fish passage, and 7.0 mg/l at 65 degrees Fahrenheit for rearing.

Water-contact recreation requires a stream that is low in coliform organisms (240 to 1,000 MPN); free from floating, suspended, or settleable solids; and aesthetically pleasing from the standpoint of turbidity, color, and aquatic growths. Achievement of these objectives requires adequate treatment of wastes, including disinfection of effluents, adequate flow throughout the stream length without pooling, and control of excessive land drainage to the stream.

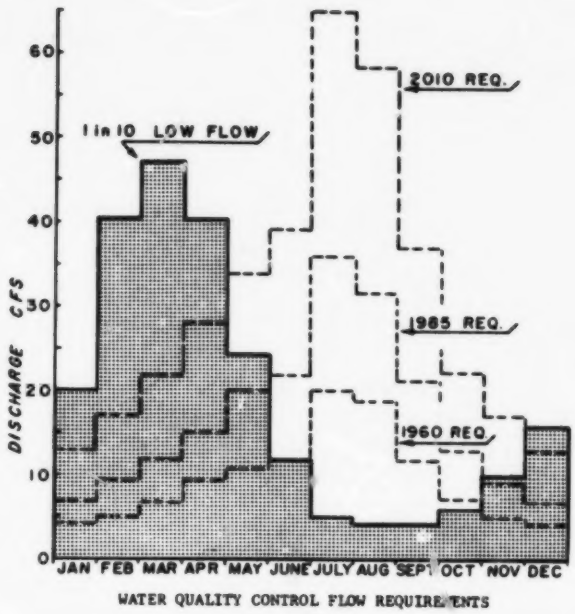
D. FLOW REGULATION

The present quality of Bear Creek during critical periods is unsuitable from a recreational, fishery, and aesthetic point of view. Streamflows essentially cease during some periods, and there is no assured flow available to receive and assimilate municipal, industrial, and agricultural wastes. Sampling data show, for example, that with a flow of 46 cfs in lower reaches of Bear Creek, the DO content is barely suitable for fish passage. With lesser flows, which occur annually, the DO concentration would fall below the requirement.

Municipal wastes from the City of Medford are, and will continue to be, treated and discharged to the Rogue River. The transmission of treated wastes from other sources along Bear Creek to the Rogue River has been considered as a means of achieving improved water quality. A private study by Jackson County and a statement by the Oregon State Sanitary Authority indicate that such transport of waste is unlikely to occur in the foreseeable future because of the high costs involved.

Adequate waste treatment, in combination with flow regulation to achieve a minimum DO level of 6 mg/l at the mouth of Bear Creek and 7 mg/l in the Ashland-Medford reach of Bear Creek on a one-in-ten year low-flow recurrence basis, would accommodate the stream uses previously described. Computations, utilizing projected waste loads and the Streeter-Phelps DO sag equation, show a need by the end of the study period for an average annual flow in Bear Creek of 30 cfs to accomplish these objectives. On a one-in-ten year low-flow recurrence basis, there would be a need for an annual draft on storage to yield 12,760 acre-feet of additional water to maintain this flow.

The typical monthly schedule of required flows and deficits for present and future years is shown in TABLE VIII-4. The flow deficiencies shown are for measurements at Medford, where diversions and return flows in the system are the most accurately typified.



WATER QUALITY CONTROL FLOW REQUIREMENTS

TABLE VIII-4
PRESENT & PROJECTED DEFICIENCIES, BEAR CREEK AT MEDFORD
TEN-YEAR RECURRENCE INTERVAL

Month	Present Flow, cfs	Required Flow, cfs 1960	1985	2010	Deficiencies 1960 cfs	1960 Ac-Ft.	1985 cfs	1985 Ac-Ft.	2010 cfs	2010 Ac-Ft.
Jan.	20	4	7	13	--	--	--	--	--	--
Feb.	41	5	9	17	--	--	--	--	--	--
March	47	7	12	22	--	--	--	--	--	--
April	41	9	15	28	--	--	--	--	--	--
May	24	11	20	34	--	--	--	--	10	615
June	12	12	22	39	--	--	10	595	27	1,660
July	5	20	36	65	15	922	31	1,900	60	3,680
Aug.	4	18	32	58	14	860	28	1,720	54	3,320
Sept.	4	12	21	37	8	476	17	1,050	33	2,070
Oct.	6	7	13	22	1	62	7	430	16	985
Nov.	10	5	9	17	--	--	--	--	7	430
Dec.	16	4	7	13	--	--	--	--	--	--
TOTAL						2,320		5,695		12,760

IX. BENEFITS....Water Quality Control

The various water uses requiring controlled water quality (fish life, recreation, and general aesthetics) were discussed in detail in Chapter VIII, Section A. Storage releases for regulation of streamflow for water quality control, in addition to adequate waste treatment, are needed to protect these uses of Bear Creek into the future. Increased flows from Ashland downstream to the mouth of Bear Creek would produce considerable benefits, both tangible and intangible. Failure to provide flow regulation for water quality control would allow further decline in quality as residual waste loads increase and would impose further limitations and restrictions on fishery programs, recreation, park developments, and property values in the area.

The minimum value of storage and delivery works for regulation of streamflow for water quality control is considered to be equal to the cost of the least-cost alternative in the absence of the project. Alternatives examined for this value determination were storage within the Bear Creek Basin, storage adjacent to the basin, and pumping from the Rogue River. The least-cost alternative was determined to be storage adjacent to the basin on McNeil Creek, a tributary of Big Butte Creek. (See location map.)

Based on this alternative, the minimum value assignable to an annual draft on storage of 12,760 acre-feet, including transmission costs to Bear Creek, a 100-year project life, needs beginning at the time of project completion, and interest at 3.125 per cent, is estimated to be $522,000 or $41.00 per acre-foot.

The benefits derived from water quality maintenance in Bear Creek are both tangible and intangible, and are widespread both in area and in type of beneficiary.

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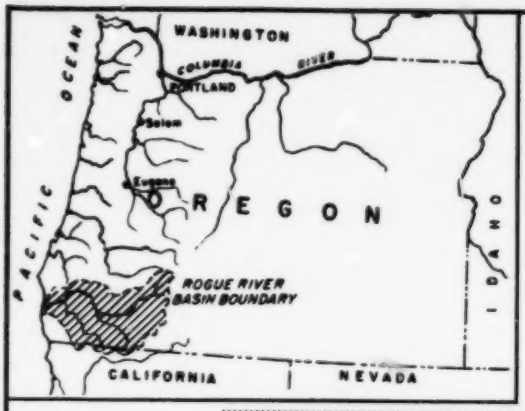

PROPOSED PROJECTS

Crater Lake
Elk Cr.
ELK CR. RESERVOIR
LOST CR. RESERVOIR
ROGUE RIVER
Big Butte Cr.
McNeil Cr.
WILLOW CR. RES.
FOUR MILE LAKE
Little Butte Cr.
Antelope Cr.
FISH LAKE
HOWARD PRAIRIE RES.
HYATT PRAIRIE RESERVOIR
Agness
Grants Pass
Illinois R.
Applegate R.
Gold Beach
PACIFIC OCEAN

▲ Gaging Station
Study Area Boundary

5 0 5 10 15
SCALE IN MILES

WATER QUALITY CONTROL STUDY
ROGUE RIVER BASIN, OREGON
MEDFORD DIVISION

LOCATION MAP

BEAR CREEK STUDY AREA

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
Public Health Service
REGION IX (Date: 10/65) PORTLAND, OREGON